National Aeronautics and Space Administration

Innovative Partnerships Program: Emulsified Zero-Valent Iron (EZVI)

NASA success story

NASA Kennedy Space Center (KSC), in partnership with the University of Central Florida (UCF) researchers, is proud to announce the successful commercialization of Emulsified Zero-Valent Iron (EZVI). This technology was designed for the in-situ treatment of dense non-aqueous phase liquids (DNAPLs) found in contaminated groundwater in the ground subsurface, and is one of the few methods that can treat the DNAPL source. EZVI also overcomes limitations with current DNAPL treatment technologies by providing a method that is quick, effective, and cost-competitive. EZVI was originally developed by NASA researchers to treat chlorinated-solvent contamination at KSC's Launch Complex 34. Based on the success of laboratory and field tests, NASA licensed EZVI to six companies that are producing their own versions of the technology.

Success Highlights

- Field-tested by the U.S. Environmental Protection Agency (EPA) under the Superfund Innovative Technology Evaluation (SITE) Program
- Selected as a winner of the 2006 Award for Excellence in Technology Transfer by the Federal Laboratory Consortium
- Used at commercial and government sites to treat both trichloroethylene (TCE) and perchloroethylene (PCE)
- Applied in multiple states, including Arkansas, Florida, Illinois, Louisiana, Massachusetts, North Carolina, Ohio, South Carolina, Tennessee, and Texas
- Available on the commercial market through six technology providers
- Selected as a winner of the NASA Government Invention of the Year and the NASA Commercialization Invention of the Year
- Inducted into the Space Technology Hall of Fame

Benefits

- **Directly treats contaminant source:** Numerous methods are available for treating dissolved phase contaminants, but EZVI is one of the few technologies that can effectively treat the DNAPL source.

- **Does not mobilize contaminants:** Many DNAPL treatment methods can mobilize DNAPLs to previously uncontaminated areas. In contrast, EZVI treats contaminants in place with no mobilization.
- **Requires less treatment time:** Although traditional pump-and-treat systems can require decades of operation for complete DNAPL removal, remediation with EZVI takes only 2–3 months.
- **Is environmentally safe:** EZVI is made from environmentally friendly and biodegradable materials.
- **Is cost-competitive:** Treatment costs using EZVI are competitive with alternative methods such as pump-and-treat, thermal treatment, and in-situ chemical oxidation.
- **Produces less toxic and more easily degradable by-products:** Other technologies can generate chlorinated daughter products that can be harmful to the environment. In contrast, EZVI produces small quantities of hydrocarbons, such as ethene, that are relatively nontoxic and naturally degraded.
- **Effective in oxidative or saline environments:** Unlike other reductive technologies, EZVI is capable of working in sites with high dissolved oxygen or saline conditions. The oil membrane around the iron particles protects the metal from competing reactions.

The Technology

Emulsified Zero-Valent Iron (EZVI) is created by placing nanoscale or microscale zero-valent iron particles into a surfactant-stabilized, biodegradable water-in-oil emulsion. This emulsion is injected into the DNAPL-contaminated zones of the subsurface. The DNAPL is then pulled into the emulsion where the contaminant reacts with the zero-valent iron. Through a process known as reductive dehalogenation, the DNAPL and its daughter products are degraded into ethene and other hydrocarbons. These by-products are finally broken down through biological activities in the subsurface. Although designed to tackle the difficulties associated with remediating DNAPLs, EZVI is also effective at treating dissolved-phase contaminants. Therefore, no separate technology is required to treat the dissolved portion in the contaminant zone.

Commercial Applications

Thousands of sites across the United States face problems with DNAPL contamination. The EPA has reported that DNAPLs are present at 60% to 70% of all sites on the Superfund National Priorities List. EZVI is a versatile technology that can be used at many of these locations. Applicable sites may include the following:

- Dye and paint manufacturers
- Dry cleaners
- Chemical manufacturers
- Metal cleaning and degreasing facilities
- Leather tanning facilities
- Pharmaceutical manufacturers
- Adhesive and aerosol manufacturers

Success

Researchers at KSC and UCF originally developed EZVI as an innovative method for treating chlorinated solvents at Kennedy Space Center's Launch Complex 34. During the 1960s, chlorinated solvents, including TCE, were used at this site to clean rocket engines. As a result, groundwater became contaminated with DNAPLs. EZVI was field-tested at Launch Complex 34 under the U.S. EPA SITE Program. Based on the success of this deployment, NASA licensed EZVI to six companies that are producing their own versions of the technology. These companies have used the technology to treat TCE and PCE in multiple states, including Arkansas, Florida, Illinois, Louisiana, Massachusetts, North Carolina, Ohio, South Carolina, Tennessee, and Texas. In 2006, EZVI was selected as a winner of the Award for Excellence in Technology Transfer by the Federal Laboratory Consortium. This annual award is given to researchers who have exhibited outstanding performance in the transfer of a technology from a federal laboratory to the commercial market.

Patents and Licenses

- U.S. Patent No. 6,664,298
- U.S. Patent No. 7,037,946
- Nonexclusively licensed to six companies

To Learn More

Additional information on EZVI is available on NASA KSC's Environmental Remediation Technologies Web Site:

http://technology.ksc.nasa.gov

Contacts

The commercial success of EZVI is the result of NASA's technology transfer program. This program seeks to simulate commercial use of NASA-developed technologies. If your company is interested in the NASA technology transfer program, please contact:

Jim Nichols
Commercialization Manager
Technology Programs & Partnerships Branch
Mail Code: KT-A2
Kennedy Space Center, FL 32899
Telephone: 321.867.6384
Fax: 321.867.2050
E-mail: Jim.Nichols@nasa.gov

Lew Parrish
Technology Programs & Partnerships Branch
Mail Code: KT-A2
Kennedy Space Center, FL 32899
Telephone: 321.867.5033
Fax: 321.867.2050
E-mail: lewis.m.parrish@nasa.gov

National Aeronautics and Space Administration
John F. Kennedy Space Center, FL
www.ksc.nasa.gov